

WETLAND HYDROLOGY



ARID WEST HYDROLOGY - INTRODUCTION

- Hydrology indicators imply a continuing wetland hydrologic regime for sites with hydrophytic vegetation and hydric soil
- Wetland hydrology indicators are meant to confirm recent episodes of inundation and/or saturation but not necessarily timing, duration or frequency
- A hydrology indicator is sufficient to confirm the presence of wetland hydrology, no measurement of duration is required
- Wetlands in the arid west may be dry for much of the year making hydrology indicators difficult to directly observe
- Lack of an indicator is not evidence for the absence of wetland hydrology
- Consider antecedent weather conditions to evaluate observed site conditions

ARID WEST HYDROLOGY - DIFFICULT SITES

- When hydrology indicators are absent from an area with hydrophytic vegetation and hydric soil further information may be required to make a wetland determination
 - + schedule one or more site visits during the wet portion of the growing season
 - + review aerial photography, gage data, NRCS Hydrology Tools
- On highly disturbed or problematic sites, direct hydrologic monitoring may be needed to determine whether wetland hydrology is present (ERDC TN WRAP 05 02)

ARID WEST HYDROLOGY - GROWING SEASON

- Corps recommends period when air temperature is above 28 degree day (WETS Table) as the standard procedure to determine the growing season dates at a particular site
- In the arid west, site specific alternative measures for determining growing season may be used
 - + above ground growth and development of vascular plants
 - + soil temperature

ARID WEST HYDROLOGY - GROWING SEASON

- The growing season has begun on a site in a given year when two or more different non-evergreen vascular plant species growing in a wetland or surrounding areas exhibit one or more of the following indicators of biologic activity:
 - 1) emergence of herbaceous plants from the ground;
 - 2) appearance of new growth from vegetative crowns
 - 3) coleoptile/cotyledon emergence from seed; 4) bud burst on woody plants; 5) emergence or elongation of leaves of woody plants; 6) emergence or opening of flowers
- The growing season has begun on a site when the soil temperature is 41 degrees F or higher at a depth of 12 inches in the soil

ARID WEST HYDROLOGY - INDICATORS

- Wetland hydrology indicators are intended as one time observations of site conditions that are sufficient evidence of wetland hydrology in areas where hydric soils and hydrophytic vegetation are present
- Wetland hydrology indicators have been placed into 4 groups
 - + Group A based on direct observation of surface or ground water
 - + Group B based on indirect evidence of recent ponding or flooding
 - + Group C based on indirect evidence of recently saturated soil
 - + Group D based on vegetation or soil features that indicate contemporary rather than historical wet conditions

ARID WEST HYDROLOGY - INDICATORS

- Indicators are rated as primary and secondary based on their regional reliability
- One primary or two secondary indicators are sufficient to conclude wetland hydrology is present
- List of hydrology indicators is not exclusive. Site specific hydrology indicators need documentation

LIST OF WETLAND HYDROLOGY INDICATORS FOR ARID WEST

Table 8. List of wetland hydrology indicators for the Arid West		
Indicator	Category	
	Primary	Secondary
Group A – Observation of Surface Water or Saturated Soils		
A1 – Surface water	X	
A2 – High water table	X	
A3 – Saturation	X	
Group B – Evidence of Recent Inundation		
B6 – Surface soil cracks	X	
B7 – Inundation visible on aerial imagery	X	
B9 – Water-stained leaves	X	
B11 – Salt crust	X	
B12 – Biotic crust	X	
B13 – Aquatic invertebrates	X	
B1 – Water marks	X	X (riverine)
B2 – Sediment deposits	X	X (riverine)
B3 – Drift deposits	X	X (riverine)
B10 – Drainage patterns		X
Group C – Evidence of Recent Soil Saturation		
C1 – Hydrogen sulfide odor	X	
C3 – Oxidized rhizospheres along living roots	X	
C4 – Presence of reduced iron	X	
C6 – Recent iron reduction in plowed soils	X	
C2 – Dry-season water table		X
C7 – Thin muck surface		X
C8 – Crayfish burrows		X
C9 – Saturation visible on aerial imagery		X
Group D – Evidence from Other Site Conditions or Data		
D3 – Shallow aquitard		X
D5 – FAC-neutral test		X

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Group A – Observation of Surface Water or Saturated Soils		
A1 – Surface water	X	
A2 – High water table	X	
A3 – Saturation	X	
Group B – Evidence of Recent Inundation		
B6 – Surface soil cracks	X	
B7 – Inundation visible on aerial imagery	X	
B9 – Water-stained leaves	X	
B11 – Salt crust	X	
B12 – Biotic crust	X	
B13 – Aquatic invertebrates	X	
B1 – Water marks	X	X (riverine)
B2 – Sediment deposits	X	X (riverine)
B3 – Drift deposits	X	X (riverine)
B10 – Drainage patterns		X
Group C – Evidence of Recent Soil Saturation		
C1 – Hydrogen sulfide odor	X	
C3 – Oxidized rhizospheres along living roots	X	
C4 – Presence of reduced iron	X	
C6 – Recent iron reduction in plowed soils	X	
C2 – Dry-season water table		X
C7 – Thin muck surface		X
C8 – Crayfish burrows		X
C9 – Saturation visible on aerial imagery		X
Group D – Evidence from Other Site Conditions or Data		
D3 – Shallow aquitard		X
D5 – FAC-neutral test		X

HYDROLOGY - 87
MANUAL / ARID WEST
SUPPLEMENT

WETLAND HYDROLOGY INDICATORS

1

87 MANUAL	ARID WEST SUPPLEMENT
INUNDATED (P)	A1 SURFACE WATER (P)
SATURATED in the UPPER 12 INCHES (P)	A2 High WATER TABLE (P) A3 SATURATION (P)
WATER MARK (P)	B1 WATER MARK (P) (S-riverine)
DRIFT LINES (P)	B3 DRIFT DEPOSIT (P) (S-riverine)
SEDIMENT DEPOSITS (P)	B2 SEDIMENT DEPOSIT (P) (S-riverine)
DRAINAGE PATTERNS in WETLANDS (P)	B10 DRAINAGE PATTERN (S)

WETLAND HYDROLOGY INDICATORS

2

87 MANUAL	ARID WEST SUPPLEMENT
OXIDIZED ROOT CHANNELS in the UPPER 12 INCHES (S)	C3 OXIDIZED RHIZOSPHERES ALONG LIVING ROOTS (P)
WATER-STAINED LEAVES (S)	B9 WATER-STAINED LEAVES (P)
LOCAL SOIL SURVEY DATA (S)	NOT USED
FAC-NEUTRAL TEST (S)	D5 FAC-NEUTRAL TEST (S)

WETLAND HYDROLOGY INDICATORS

3

87 MANUAL	ARID WEST SUPPLEMENT
NONE	B6 SURFACE SOIL CRACKS (P)
RECORDED DATA	B7 INUNDATION VISIBLE ON AERIAL IMAGERY (P)
NONE	B11 SALT CRUSTS (P)
NONE	B12 BIOTIC CRUSTS (P)
NONE	B13 AQUATIC INVERTEBRATES (P)
NONE	C1 HYDROGEN SULFIDE ODOR (P)
NONE	C4 PRESENCE OF REDUCED IRON (P)
NONE	C6 RECENT IRON REDUCTION IN PLOWED SOIL (P)

WETLAND HYDROLOGY INDICATORS

4

87 MANUAL	ARID WEST SUPPLEMENT
NONE	C2 DRY-SEASON WATER TABLE (S)
NONE	C7 THIN MUCK SURFACE (S)
NONE	C8 CRAYFISH BURROWS (S)
RECORDED DATA	C9 SATURATION VISIBLE ON AERIAL IMAGE (S)
NONE	D3 SHALLOW AQUITARD (S)

HYDROLOGY SECTION - DATA

SHEET 87 MANUAL

HYDROLOGY

- ☐ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
 - ☐ Aerial Photographs
 - ☐ Other
- ☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)

Depth to Free Water in Pit: _____ (in.)

Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators:

Primary Indicators:

- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):

- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks:

HYDROLOGY SECTION - ARID WEST SUPPLEMENT

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (any one indicator is sufficient)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) (Nonriverine)
- ☐ Sediment Deposits (B2) (Nonriverine)
- ☐ Drift Deposits (B3) (Nonriverine)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)

- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Plowed Soils (C6)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) (Riverine)
- ☐ Sediment Deposits (B2) (Riverine)
- ☐ Drift Deposits (B3) (Riverine)
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Thin Muck Surface (C7)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

Field Observations:

- Surface Water Present? Yes ☐ No ☐ Depth (inches): _____
- Water Table Present? Yes ☐ No ☐ Depth (inches): _____
- Saturation Present? Yes ☐ No ☐ Depth (inches): _____
(includes capillary fringe)

Wetland Hydrology Present? Yes ☐ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

HYDROLOGY - A1 SURFACE WATER

- direct, visual observation of surface water (flooding or ponding) during a site visit
- primary
- ponded or flooded sites must be evaluated for recent abnormal weather conditions and status of growing season. Surface water may be absent from seasonal wetlands during the dry season or from wetlands with sub-surface saturation

A1 - SURFACE WATER



Figure 4-1. Wetland with surface water present.

HYDROLOGY - A2 HIGH WATER TABLE

- direct visual observation of a water table within 12 inches of the soil surface. This indicator includes perched water tables and discharge water tables (e,g, seeps) where water may enter the hole from surface soil layers
- primary
- allow soil water time to stabilize in the hole. If outside of growing season determine if water table would persist for sufficient duration during the growing season. Consider recent and long-term precipitation amounts. Soil pit should not penetrate restrictive soil horizons.

A2 - HIGH WATER TABLE



Figure 4-2. High water table observed in a soil pit.

HYDROLOGY - A3 SATURATION

- visual observation of saturated soil conditions within 12 inches from the soil surface as indicated by water glistening on the surfaces and broken interior faces of soil samples removed from the soil pit. This indicator must be associated with an existing water table located immediately below the saturated zone.
- primary
- recent rainfall events and proximity of water table to the soil surface must be considered in applying this indicator. Water observed in soil cracks or on ped faces do not meet this indicator unless ped interiors are also saturated

A3 - SATURATION



Figure 4-3. Water glistens on the surface of a saturated soil sample.

HYDROLOGY - B6 SURFACE SOIL CRACKS

- Surface soil cracks consist of shallow cracks that form when fine grained mineral or organic sediments dry and shrink, creating a network of cracks or small polygons
- Primary
- Soil cracks are common in fine sediments in seasonally ponded depressions but can also occur in temporary ponds or puddles in non-wetlands. Does not include soil cracks in Vertisols or biotic crusts

B6 - SURFACE SOIL CRACKS



Figure 4-4. Surface soil cracks in a seasonally ponded wetland.

HYDROLOGY - B7 INUNDATION VISIBLE ON AERIAL IMAGERY

- One or more recent aerial photographs or satellite images show the site to be inundated
- Primary
- Consider antecedent weather conditions to evaluate imagery. Consider status of growing season. Surface water may be absent during dry season, drought conditions early in the ppt season, in some wetland types or not every year. If 5 years of photos are available NRCS method for evaluating photos is recommended (1997, section 650.1903).

HYDROLOGY - B9 WATER-STAINED LEAVES

- Water stained leaves are fallen leaves that have turned grayish or blackish in color due to inundation for long periods.
- Primary
- Not common in arid west but known to occur in depressional wetlands and along streams with woody vegetation. Water stained leaves should contrast in color with fallen leaves in nearby non-wetland areas.

HYDROLOGY -B11 SALT CRUST

- Salt crusts are hard or brittle deposits of salts formed on the ground surface due to the evaporation of saline surface water.
- Primary
- Salt crusts typically form in ponded depressions, seeps and lake fringes. Salt crusts do not include fluffy salt deposits or efflorescences resulting from capillary rise and evaporation of saline groundwater that may be derived from a deep water table.

B11 - SALT CRUST



Figure 4-5. A hard salt crust in a dry temporary pool (25-cent coin for scale).

HYDROLOGY - B12 BIOTIC CRUSTS

- This indicator includes ponding-remnant biotic crusts, benthic microflora, and the dries remains of free floating algae left on or near the soil surface after dewatering.
- Primary
- Biotic crusts are soil aggregates held together by microorganisms (blue-green algae, green algae, diatoms, lichens and fungi) and the substances they produce. Ponding-remnent crusts often form polygons with upturned edges. Dried algal mats are common features of seasonally flooded wetlands.

B12 - BIOTIC CRUST



Figure 4-6. Ponding-remnant biotic crusts on the surfaces of mud-crack polygons. Biotic crusts often have up-turned edges with the surface layer darker than the underlying material.

HYDROLOGY- B13 AQUATIC INVERTEBRATES

- Presence of numerous live individuals, diapausing insect eggs or crustacean cysts, or dead remains of aquatic invertebrates, such as clams, snails, insects, ostracods, shrimp, and other crustaceans on the soil surface.
- Primary
- Shells, exoskeletons, clam valves etc should be numerous and not imported or relic.

B13 - AQUATIC INVERTEBRATES



Figure 4-14. Carapaces of tadpole shrimp (*Triops* sp.) and clam shrimp (*Leptestheria compleximannus*) in dried sediments of an ephemeral pool. Photo by Brian Lang (New Mexico Dept. of Game & Fish).

HYDROLOGY - B1 WATER MARKS

- Water marks are discolorations or stains on the bark of woody vegetation, rocks, bridge pillars, buildings, fences, or other fixed objects as a result of inundation.
- Primary (Secondary in Riverine situations)
- When several water marks are present, the highest reflects the maximum extent of recent inundation and can be used to indicate the water-level elevation. Consider water marks left by extreme, infrequent or brief flooding events. Water marks often reflect higher than normal flows and should be considered a secondary indicator in riverine situations within the region.

B1 - WATER MARKS



Figure 4-15. Water marks on a boulder.

HYDROLOGY - B2 SEDIMENT DEPOSITS

- Sediment deposits are thin layers or coatings of fine-grained mineral material (e.g. silt, clay) or organic matter (e.g. pollen), sometimes mixed with other detritus, remaining on tree bark, plant stems or leaves, rocks and other objects after surface water recedes.
- Primary (Secondary in Riverine situations)
- Generally occurs in ponded situations where water stood long enough to allow suspended sediment to settle. Sediment deposits indicate the minimum level of inundation and can be extrapolated across lower elevations. Sediment deposits may be left by extreme events or infrequent high flows. Sediment deposits may reflect higher than normal flows and should be considered secondary indicators in riverine situations within the region.

B2 - SEDIMENT DEPOSITS



Figure 4-16. Sediment deposits (tan coloration) on tree bases in a seasonally flooded area.

HYDROLOGY - B3 DRIFT DEPOSITS

- Drift deposits consist of rafted debris that has been deposited on the ground surface or entangled in vegetation or other fixed objects. Drift material may be deposited at or near the high water line in ponded or flooded areas, piled against the upstream side of trees, rocks, and other fixed objects, or widely distributed within the dewatered area.
- Primary (Secondary in Riverine situations)
- Commonly found along streams, tidal marshes, lake shores and ponded areas. The elevation of the drift line can be extrapolated across the lower elevation areas. Drift lines can be caused by extreme, infrequent or brief flooding events and may exist for years in arid regions. Drift deposits may be the result of higher than normal flows and should be considered secondary indicators in riverine situations within the region.

B3 - DRIFT DEPOSITS



Figure 4-17. Drift deposit on the upstream side of a sapling in a floodplain wetland.

HYDROLOGY - B10 DRAINAGE PATTERNS

- This indicator includes flow patterns visible on the soil surface or eroded into the soil, low vegetation bent over in the direction of flow, absence of leaf litter or small woody debris due to flowing water, and similar evidence that water flowed across the ground surface.
- Secondary
- Generally seen where water flows over the surface and is not confined within a channel. Consider areas affected by recent extreme or unusual flooding events.

B10 - DRAINAGE PATTERNS



Figure 4-18. Vegetation bent over in the direction of water flow across a stream terrace.

HYDROLOGY - C1 HYDROGEN SULFIDE ODOR

- A hydrogen sulfide odor (rotten egg) within 12 inches of the soil surface.
- Primary
- Odor produced in response to prolonged soil saturation and to be detectable the soil must have been saturated long enough to be very reduced. Hydrogen sulfide serves as both an indicator of hydric soil and wetland hydrology.

HYDROLOGY - C3 OXIDIZED RHIZOSPHERES ALONG LIVING ROOTS

- This indicator consists of iron oxide coatings or plaques on the surface of living roots and/or iron oxide coatings or linings on soil pores immediately surrounding living roots within 12 inches of the soil surface and occupying at least 2% of the volume of the soil layer.
- Primary
- Oxidized rhizospheres are evidence of saturation and reduction during the plant lifetime. Oxidized iron must be associated with living roots to indicate contemporary wet conditions. Distinguish between organic material associated with root and oxidized iron.

C3 - OXIDIZED RHIZOSPHERES ALONG LIVING ROOTS



Figure 4-19. Iron oxide plaque (orange coating) on a living root. Iron also coats the channel or pore from which the root was removed.

HYDROLOGY - C4 PRESENCE OF REDUCED IRON

- Presence of reduced (ferrous) iron in the upper 12 inches of the soil profile, as indicated by a ferrous iron test or by the presence of a soil that changes color upon exposure to air.
- Primary
- The presence of ferrous iron can be verified with alpha, alpha-dipyrridyl dye (NRCS Hydric Soils Technical Note 8) or observing a soil that changes color upon exposure to air. Saturated soil low in weatherable iron may not exhibit a positive reaction to the dye or exposure to air.

C4 - PRESENCE OF REDUCED IRON



Figure 4-20. When alpha, alpha-dipyridyl dye is applied to a soil containing reduced iron, a positive reaction is indicated by a pink or red coloration to the treated area.

HYDROLOGY - C6 RECENT IRON REDUCTION IN PLOWED SOIL

- Presence of 2% or more redox concentrations as pore linings in the plowed surface layer of soils cultivated within the last two years.
- Primary
- Cultivation breaks up or destroys redox features in the plow zone. The presence of intact redox features indicates that the soil was saturated and reduced since the last episode of cultivation. Use caution with relic features that may be broken up but not destroyed by plowing. The indicator is most reliable in areas that are cultivated regularly, so that soil aggregates and older redox features are more likely to be broken up.

C6 - RECENT IRON REDUCTION IN PLOWED SOIL



Figure 4-21. Redox concentrations in a recently cultivated soil.

HYDROLOGY - C 2 DRY SEASON WATER TABLE

- Visual observation of the water table between 12 and 24 inches below the surface during the normal dry season or during a drier than normal year.
- Secondary
- A water table between 12 and 24 inches during the dry season, or during an abnormally dry year, indicates a normal wet-season water table within 12 inches. Wetlands with seasonally perched water tables do not have dry season water tables.
- A dry season water table below 24 inches does not necessarily indicate a lack of wetland hydrology.

HYDROLOGY - C7 THIN MUCK SURFACE

- This indicator consists of a layer of muck 1 inch or less thick on the soil surface.
- Secondary
- In a dry climate, muck accumulates only where soils are saturated to the surface for long periods each year. Thin muck surfaces disappear quickly or become incorporated into mineral horizons when wetland hydrology is removed. The presence of a thin muck layer on the soil surface indicates an active wetland hydrology regime.

HYDROLOGY - C8 CRAYFISH BURROWS

- Presence of crayfish burrows, as indicated by openings in soft ground up to 2 inches in diameter, often surrounded by chimney-like mounds of excavated mud.
- Secondary
- Crayfish burrows are usually found near streams, ditches, and ponds in areas that are seasonally inundated or have seasonal high water tables

C8 - CRAYFISH BURROWS



Figure 4-22. Crayfish burrow.

HYDROLOGY - C9 SATURATION VISIBLE ON AERIAL IMAGERY

- One or more recent aerial photographs or satellite images show soil saturation. Saturated soil signatures must correspond to field verified hydric soils, depressions or drainage patterns, differential crop management, or other evidence of a seasonal high water table.
- Secondary
- Indicator useful when plant cover is sparse and ground surface is visible on image. Saturated areas generally reflect a darker signature than adjacent non-saturated areas. Consider antecedent weather conditions and dates of growing season for the date of the image to identify extreme or abnormal conditions. Indicator requires onsite verification that saturated signatures correspond to hydric soil or other evidence of a seasonal high water table.

C9 - SATURATION VISABLE ON AERIAL IMAGERY



Figure 4-23. Aerial photograph of an agricultural field with saturated soils indicated by darker colors.

HYDROLOGY - D3 SHALLOW AQUITARD

- This indicator occurs in and around the margins of depressions, such as temporary pools, and consists of the presence of an aquitard within the soil profile that is potentially capable of perching water within 12 inches of the surface. Indicators of hydrophytic vegetation and hydric soils must also be present.
- Secondary
- An aquitard is a relatively impermeable soil layer or bedrock that slows or stops the downward infiltration of water and can produce a perched water table, generally in flat or depressional landforms. Potential aquitards include fragipans, cemented layers, dense glacial till, lacustrine deposits, and clay layers. Often redoximorphic features are evident in the layers above the aquitard.

HYDROLOGY - D5 FAC- NEUTRAL TEST

- The plant community passes the Fac-neutral test.
- Secondary
- The Fac-neutral test is performed by compiling a list of dominant plant species across all strata in the community, and dropping from the list any species with a Fac indicator status. The Fac-neutral test is met if >50% of the remaining dominant species are rated FacW and/or Obl. If there are an equal number of dominants that are Obl and FacW versus FacU and Upl, nondominant species should be considered. This indicator is only applicable to wetland hydrology determinations.